

## A NEW PROBLEMATICAL HYGROMIIDAE FROM THE AEOLIAN ISLANDS (ITALY) (PULMONATA: HELICOIDEA)<sup>1</sup>

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### ABSTRACT

*Helicotricha* n. gen. is proposed for a very small hygromiid from the Aeolian Islands, Italy: *H. carusoi* n. sp. The new species has a shell with persistent postembryonal hairs and is characterized anatomically by: a right ommatophore retractor independent of the genitalia; a penial nerve originating from the right cerebral ganglion; a vaginal complex with digitiform glands and dart-sac complex consisting of two couples of stylophores disposed on opposite sides of the vagina (each couple is formed by a larger dart-bearing outer stylophore and a smaller dartless inner stylophore); and a penial complex with a very peculiar penial papilla. Direct anatomical comparison of the new genus with other genera of the Hygromiidae suggested that it may be very closely related to *Microxeromagna*. This hypothesis was subsequently found to be supported by the results of cladistic analysis. New evidence is thus provided to confirm that the distinction between the Hygromiinae and the Trichiinae is artificial. A neotype is designated for *Helix aetnea* Benoit, 1857, a junior synonym of *Xerotricha conspurcata* (Draparnaud, 1801), and the presence of *Helicopsis* (s. str.) in western North Africa is confirmed.

Key words: Hygromiidae, Aeolian Islands, Italy, western Mediterranean, *Helicella*, *Xerotricha*, *Helicopsis*, systematics.

### INTRODUCTION

Recent insular equilibrium theory studies based on analytical comparison of the malacofaunas of the Tuscan and Aeolian archipelagos, Italy (Piantelli et al., 1990), have motivated new field research and study of the material collected from the various islands. As happened for the islands of the Tuscan Archipelago (Giusti & Manganelli, 1989, 1990), new data emerged for the Aeolians. A new species of the Hygromiidae was identified amongst material of *Xerotricha conspurcata* (Draparnaud, 1801) collected in all the Aeolian Islands. The Hygromiidae are a group of helicoids of western Palaearctic distribution recently separated from the Helicidae as a distinct family and characterized by a bursa copulatrix duct free from the diaphragm wall and a variable number of stylophores.

The peculiar structure of the genitalia made it difficult to establish relationships and generic status of the new species. Although the 2 + 2 structure of the dart-sac complex associated with the vagina, and the right ommatophore retractor free of penis and vagina, at first glance suggested a relationship with

the genus *Helicopsis*, details of the penial complex suggested other possibilities. In particular, as in the case of *Helicella* (one large, evident and one vestigial, externally invisible, stylophore on opposite sides of the vagina) and *Xerolenta* (one normal and one modified stylophore on opposite sides of the vagina) which appear to form monophyletic groups respectively with *Candidula* (one large, evident and one vestigial, externally invisible, stylophore on one side of the vagina) and *Xeromunda* (one normal and one modified stylophore on one side of the vagina) respectively (Hausdorf, 1988, 1990a; Giusti & Manganelli, 1989; Manganelli & Giusti, 1989), it seems highly probable that the new genus (one larger outer stylophore and one smaller dartless inner stylophore on opposite sides of the vagina) is a member of the monophyletic group to which also *Microxeromagna* (one larger outer stylophore and one smaller dartless inner stylophore on one side of the vagina) belongs. Accordingly, in view of the fact that *Helicella*, *Xerolenta*, *Candidula*, *Xeromunda* are unanimously regarded as distinct generic taxa and in view also of our considerations on character weighting in establish-

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ing systematic rank in the Hygromiidae (Manganelli & Giusti, 1988), a new genus is introduced for the new species.

#### MATERIALS AND METHODS

Empty shells and whole specimens were collected in the litter or under stones and wood on rocky slopes of the islands (locality data follows species description). Living specimens were left in water to drown for 24 h then preserved in ethanol 75%. Relaxed material was studied by optical microscopy (Wild M5A). Bodies were isolated then dissected using thin, pointed watchmaker's forceps. Images of isolated portions of body and genitalia were drawn using a Wild camera lucida. Radulae were manually extracted from buccal bulbs, then washed in pure 75% ethanol, mounted on copper blocks with electron-conductive glue, sputter-coated with gold and photographed using a Philips 505 SEM.

All shell parameters—shell maximum diameter, shell height, aperture maximum diameter, aperture height—were measured in variable numbers of shells from the different islands using a Wild M5A microscope and a millimetric lens. Whole shells were photographed under optical microscope. Whole shells and shell surface details were photographed under optical and scanning electron microscopes using the procedure described for the radulae.

Detailed study of the genitalia followed, particularly the distal portion (penis and vagina), the external and internal details of which proved to be diagnostic characters in similar previous studies (see literature cited in the Discussion) (Table 2).

The entire set of character states was used for classical evolutionary and cladistic analysis to define the new genus.

Cladistic analysis was performed using the method of phylogenetic systematics as originally developed by Hennig (1966), who maintained that only strictly monophyletic taxa may be regarded as historical entities and demonstrated that the only logical basis for inferring monophyly is by showing synapomorphies. The distribution of the synapomorphies is determined by the parsimony criterion (minimizing homoplasy). On the basis of these synapomorphies, the taxa are ordered into a specific pattern represented by a hierarchical branching diagram.

The new genus *Helicotricha* belongs to the family Hygromiidae, which is delimited by the following unique combination of features:

bursa copulatrix free from diaphragm; variable number of stylophores (2 + 2; 0 + 2; 1 + 1; 0 + 1; 0 + 0); stylophores, when present and not extremely regressed or modified, forming dart-sac complex consisting of one or two double units with a common base and distinct distal sacs lying side by side in the same plane; diverticulum of bursa copulatrix absent; digitiform gland tufts variable in number inserted on proximal vagina not close to where dart sacs, when present, open into vagina. Helicidae are characterized by: bursa copulatrix inserted into diaphragm; dart-sac complex consisting of a single stylophore; diverticulum of bursa copulatrix duct present. Helicidae and Hygromiidae share the following characters: dart-sac complex, vaginal digitiform glands.

Twenty (Table 1) genera are considered to be the terminal taxa. The minute details of the distal genitalia of some have recently been reviewed (Schileyko, 1978a, 1978b; Giusti & Manganelli, 1987, 1989; Hausdorf, 1988, 1990a, 1990b; Manganelli & Giusti, 1988, 1989).

In the case of the two sets of genera reviewed by Schileyko and Hausdorf, some characters were uncertain or not discussed. A question mark sometimes follows or substitutes the character states in Table 3. A question mark also substitutes the character states when one character is known to be present with more than two states in the same taxa (character 5 in *Xeromunda* and *Cernuella* (s. str.); character 16 in *Xerotricha*). Character polarity was determined by outgroup comparison methods (Watrous & Wheeler, 1981; Maddison et al., 1984) using the family collectively Helicidae as outgroup, because there is no single genus that is a clear sister group. Three out fifteen characters (5, 10, 15) had more than two character states. These characters were treated as nonadditive. Two characters (11, 14) were autoapomorphies, with an additional autoapomorphy in a multi-state nonadditive character (10).

The data was analyzed using a Wagner parsimony algorithm from Farris's phylogenetic program HENNIG86, applying the implicit enumeration option for calculating trees (version 1.5; Farris, 1989; see also Platnick, 1989) run on a IBM AT computer. When cladistic analysis yielded more than one tree, the Nelsen consensus method was applied (Nelsen, 1979). We also used the successive weighting procedure (Farris, 1989), which calculates weights from the best fits to the most parsimonious trees, and applied them in the

TABLE 1. Acronyms, genus-group taxa, type species and bibliographical sources of anatomical data. Some of the genera listed have a subgeneric division. For cladistic analysis, only species of nominotypical subgenera have been considered.

Acronyms	Genus-group taxa	Type-species	Sources
CAND	<i>Candidula</i> Kobelt, 1871	<i>Glischrus (Helix) candidula</i> , Studer, 1820, = <i>Helix unifasciata</i> Poiret, 1801	Hausdorf, 1988: ( <i>C. unifasciata</i> , <i>C. gigaxii</i> ); personal unpublished data on <i>C. spadae</i> , <i>C. intersecta</i> , <i>C. unifasciata</i>
CAUC	<i>Caucasigena</i> Lindholm, 1927	<i>Helix eichwaldi</i> Pfeiffer, 1846	Schileyko, 1978a, 1978b
CERN	<i>Cernuella</i> Schluter, 1838	<i>Helix variabilis</i> Draparnaud, 1801, = <i>Cochlea virgata</i> Da Costa, 1778	Hausdorf, 1988; Manganelli & Giusti, 1988
EDEN	<i>Edentiella</i> Polinski, 1929	<i>Helix edentula</i> Draparnaud, 1805	Schileyko, 1978a, 1978b
HELL	<i>Helicella</i> Férussac, 1821	<i>Helix itala</i> Linnaeus, 1758; cf. Opinion 431	Hausdorf, 1988; Giusti & Manganelli, 1989
HELP	<i>Helicopsis</i> Fitzinger, 1833	<i>Helix striata</i> Müller, 1774	Giusti & Manganelli, 1989; Schileyko, 1978b; Hausdorf, 1990b
HELT	<i>Helicotricha</i> Giusti & Manganelli, 1992	<i>Helicotricha carusoi</i> Giusti, Manganelli & Crista, 1992	this paper
HYGR	<i>Hygromia</i> Risso, 1826	<i>Helix cinctella</i> Draparnaud, 1801	Giusti & Manganelli, 1987
HYGH	<i>Hygrohelicopsis</i> Schileyko, 1978a	<i>Hygrohelicopsis darevskii</i> Schileyko, 1978a	Schileyko, 1978a, 1978b
KOKO	<i>Kokotschashvilia</i> Hudec & Lezhawa, 1969	<i>Helix holotricha</i> O. Boettger, 1884	Schileyko, 1978a, 1978b
LEUC	<i>Leucozonella</i> Lindholm, 1927	<i>Helix rubens</i> von Martens, 1874	Schileyko, 1978a, 1978b
MICR	<i>Microxeromagna</i> Ortiz de Zarate Lopez, 1950	<i>Helix stolismena</i> Bourguignat, in Servain, 1880, = <i>Helix armillata</i> Lowe, 1852	Hausdorf, 1988, 1990c; Manganelli & Giusti, 1988
NANA	<i>Nanaja</i> Schileyko, 1978b	<i>Nanaja cumulata</i> Schileyko, 1978b	Schileyko, 1978b
PLIC	<i>Pliciteria</i> Schileyko, 1978a	<i>Helix lubomirskii</i> Slosarski, 1881	Schileyko, 1978a, 1978b
PXER	<i>Pseudoxerophila</i> Westerlund, in Westerlund & Blanc, 1879	<i>Helix (Pseudoxerophila) bathytera</i> Westerlund, in Westerlund & Blanc, 1879	Hausdorf, 1988
TRIC	<i>Trichia</i> , Hartmann, 1840	<i>Helix hispida</i> Linnaeus, 1758	Schileyko, 1978a, 1978b
XERL	<i>Xerolenta</i> Monterosato, 1892	<i>Helix obvia</i> Menke, 1828	Hausdorf, 1988
XERM	<i>Xeromunda</i> Monterosato, 1892	<i>Helix turbinata</i> , sensu Monterosato, 1892, non De Cristofori & Jan, 1832) (cf. Hausdorf, 1988; Manganelli & Giusti, 1988; 1989; an application to the I.C.Z.N. is in progress by Giusti & Manganelli)	Hausdorf, 1988, 1990a; Manganelli & Giusti, 1989
XERS	<i>Xerosecta</i> Monterosato, 1892	<i>Helix explanata</i> Müller, 1774	Manganelli & Giusti, 1988
XERT	<i>Xerotricha</i> Monterosato, 1892	<i>Helix conspurcata</i> Draparnaud, 1801	Hausdorf, 1988; Giusti & Manganelli, 1989

weighting procedure until there were no changes in successively produced trees.

## SYSTEMATIC DESCRIPTION

### *Helicotricha* n. gen

#### Diagnosis

Very small hygromiid with shell having persistent postembryonal hairs; anatomically characterized by right ommatophore retractor independent of genitalia; penial nerve from

right cerebral ganglion; vaginal complex with digitiform glands and dart-sac complex consisting of two pairs of stylophores, each couple comprising a larger dart-bearing outer stylophore and a smaller dartless inner stylophore; penial complex having a very peculiar penial papilla.

#### Description

*Shell*: Small, hairy, opaque-brown in colour, with white flecks. Spire consisting of approx-

TABLE 2. List of characters

## 1—Penial nerve.

—From right cerebral ganglion = 0

—From right pedal ganglion = 1

Remarks: no data for *Caucasigena*, *Edentiella*, *Hygrohelicopsis*, *Kokotschashvilia*, *Leucozonella*, *Nanaja*, *Plicuteria*. In Manganelli & Giusti (1989: 4) was wrongly reported for *Xeramunda* "from right pedal ganglion." Revision of original data indicates that penial nerve comes out of right cerebral ganglion.

## 2—Right ommatophore retractor.

—Between penis and vagina = 0

—Independent of penis and vagina = 1

Remarks: No data for *Pseudoxerophila*.

## 3—Number of stylophores and/or their derivates forming the dart-sac complex.

—2 + 2 = 0

—0 + 2 = 1

## 4—Shape and position of stylophore groups in relation to vagina.

—Stylophores *Trichia* type: each stylophore group (each composed of an outer and an inner stylophore) slender and entering vagina through a slender neck (Manganelli & Giusti, 1988: fig. 14 E) = 0—Stylophores not *Trichia* type: each stylophore group (each composed of an outer and an inner stylophore) wide and fused to inner walls of vagina for a long tract (Manganelli & Giusti, 1988: fig. 14 A) = 1

Remarks: *Helicopsis*: based on the type species only (Giusti & Manganelli, 1989). Schileyko (1978b) and Hausdorf (1990b) show drawings of the genitalia of *H. striata* and of some other species (*H. likharevi*, *H. retowskii*) in which the situation is slightly different. A slightly different situation also occurs in the species studied in the present paper and referred to as *Helicopsis* sp.

## 5—Shape and dimensions of stylophore groups.

—Each group formed by an inner and an outer stylophore of similar dimensions (Manganelli &amp; Giusti, 1988: fig. 14 A) = 0

—Each group consisting of large outer stylophore and small externally visible inner stylophore (Giusti &amp; Manganelli, 1989: fig. 9 A) = 1

—Each group consisting of large outer stylophore and externally visible residues of the inner stylophore (Manganelli &amp; Giusti, 1989: fig. 1 E) = 2

—Each group consisting of larger outer stylophore and very small, not externally visible, inner stylophore (Schileyko, 1987a: fig. 43) = 3

—Each group consisting of large outer stylophore and extremely reduced not externally visible inner stylophore (Giusti &amp; Manganelli, 1989: fig. 9 C) = 4

Remarks: the scheme of the dart-sac complex in *Helicella* reproduced by Hausdorf (1988: fig. 8) is incorrect: the inner stylophore, referred to as "Nebensack," appears too large and externally visible.

## 6—Digitiform glands.

—All around vagina = 0

—On one side of vagina = 1

Remarks: situation not clear enough in drawings by Schileyko (1978a, 1978b) of the genitalia of *Edentiella*, *Nanaja* and *Plicuteria*. The situation in *Hygrohelicopsis* and *Leucozonella* showed by the same author (Schileyko, 1978a, 1978b) seems to indicate digitiform glands all around vagina. Species of *Cernuella* (s. str.) show digitiform glands all around vagina (*C. caruanae*) or on one side of the vagina (*C. virgata*).

## 7—Basal portion

—Stylophore groups opening directly into vagina without a wide basal dilated portion (Manganelli &amp; Giusti, 1988: fig. 14 E) = 0

—Stylophore groups opening in a wide dilated basal portion (Manganelli &amp; Giusti, 1989: fig. 1 E) = 1

## 8—Inner stylophores.

—With thin muscular walls and large internal cavity (Manganelli &amp; Giusti, 1988: fig. 14 E) = 0

—With thick muscular walls and small internal cavity (Manganelli &amp; Giusti, 1988: fig. 14 A) = 1

Remarks: transverse and longitudinal sections of dart-sac complex in *Edentiella*, *Kokotschashvilia*, *Leucozonella*, *Nanaja*, *Plicuteria* unknown. Situation as reported by Schileyko (1978a, 1978b) for *Caucasigena* and *Hygrohelicopsis* not clear enough.

## 9—Opening of stylophores.

—Openings of inner and outer stylophore cavities into vagina close to each other (Manganelli & Giusti, 1988: fig. 14 E) = 0

—Openings of inner and outer stylophore cavities into vagina very far apart (Manganelli & Giusti, 1988: fig. 14 A) = 1

## 10—Inner vaginal accessory structures.

—Opening of stylophores in a groove bordered by folds (Manganelli & Giusti, 1988: fig. 8 A) = 0

—Opening of stylophores bordered by rows of papillae (Schileyko, 1987b: fig. 215) = 1

—Vagina with one tongue-like structure for each stylophore group (two tongue-like structures when 2 stylophore groups present) (Giusti & Manganelli, 1989: figs. 3, 9A) = 2

—Vagina with a groove-like structure for each stylophore group (unique tube-like structure when 2 stylophore groups present) (Giusti & Manganelli, 1989: figs. 7, 9 C) = 3

—Vagina with dart-gun through which dart is shoot (Manganelli & Giusti, 1989: figs. 4 E, 14 A) = 4

## 11—Joint of penis and vagina

—Penis joins vagina distally with respect to stylophores (Manganelli & Giusti, 1989: Fig. 5 F) = 0

—Penis joins distal vagina level with stylophores (Manganelli & Giusti, 1989: fig. 8 B) = 1

## 12—Proximal penis.

—Proximal penis *Helicopsis* type: transverse sections reveal a duct in the lumen; this duct joins the epiphallus lumen directly with the ejaculatory canal of the penial papilla (Giusti & Manganelli, 1989: fig. 8 F, H) = 0.

—Proximal penis simple: transverse sections only show the penial walls (Manganelli & Giusti, 1988: fig. 11 F) = 1.

Remarks: A structure, only apparently similar to those in *Helicopsis*, seems present in drawings by Manganelli & Giusti (1990: figs. 2C, 3A, 4E for *Xeromunda*), Schileyko (1978b: Fig. 253 for "*Helicella candicans*"), Schileyko, in Damjanov & Likharev (1975: fig. 274, for "*Helicella candicans*" and fig. 278 for "*Helicella spiruloides*"). This is due to the fact that the thin external layer of the penis has been detached during dissection.

## 13—Glandular area on one side of terminal penis walls.

—absent = 0

—present (this paper: Fig. 3) = 1

Remarks: no data for *Caucasigena*, *Edentiella*, *Hygrohelicopsis*, *Kokotschashvilia*, *Leucozonella*, *Nanaja*, *Plicuteria*, *Pseudoxerophila*; for *Microxeromagna* unpublished personal data.

## 14—Frenula.

—Penial papilla with no frenula joining it to the distal penis walls (Manganelli & Giusti, 1988: fig. 7 F–H) = 0

—Penial papilla joined by frenula to the distal penis walls (Manganelli & Giusti, 1988: fig. 6 C–D) = 1

## 15—Sections of penial papilla.

—*Trichia* type (Schileyko, 1978b: fig. 221) = 0

—*Caucasigena* type (Schileyko, 1978b: fig. 199) = 1

—*Xerosecta* type (Manganelli & Giusti, 1988: fig. 8 C) = 2

—*Helicotricha* type (this paper: Fig. 3C) = 3

—*Microxeromagna* type (Manganelli & Giusti, 1988: fig. 11 E) = 4

—*Leucozonella* type (Schileyko, 1978b: fig. 146) = 5

—*Cernuella* type (Manganelli & Giusti, 1988: fig. 7 G) = 6

Remarks: Species of *Xerotricha* have sections of penial papilla of *Trichia* type (*X. apicina*) and of *Cernuella* type (*X. conspurcata*). Due to variability, *Leucozonella* is based only on the type-species.

imately 4 whorls separated by deep sutures, last whorl angled at periphery. Umbilicus open, wide approximately 1/5 of maximum shell diameter. Aperture oblique, oval, lacking internal rib. Peristome not thickened or reflexed. External surface of protoconch with few faint growth lines and microsculpture con-

sisting of fine close longitudinal grooves. External surface of teleoconch with superficially reticulated periostracal layer and transverse rows of very short hairs.

*Genitalia*: Vaginal complex with relatively long distal vagina; dart-sac complex consisting of

TABLE 3. Original data matrix used for cladistic analysis. All characters with more than two states are treated as not additive.

Taxa	Character														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Outgroup	0	0	?	?	?	0	0	?	?	0	0	?	0	0	?
<i>Candidula</i>	1	1	1	1	4	1	0	1	0	3	0	1	0	0	6
<i>Caucasigena</i>	?	0	0	0	0	1	0	0	0	0	0	1	?	0	1
<i>Cernuella</i>	1	1	1	1	0	?	0	0	1	4	1	1	0	1	6
<i>Edentiella</i>	?	0	0	0	0	?	0	?	0	0	0	1	?	0	1
<i>Helicella</i>	1	1	0	1	4	1	0	1	0	3	0	1	0	0	6
<i>Helicopsis</i>	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
<i>Helicotricha</i>	0	1	0	0	0	1	0	1	0	0	0	1	1	0	3
<i>Hygrohelicopsis</i>	?	1	0	1	3	1	0	0	0	0	0	?	?	0	0
<i>Hygromia</i>	0	0	1	1	0	1	0	0	1	4	0	1	0	0	6
<i>Kokotschashvilia</i>	?	0	0	0	0	1	0	?	0	0	0	?	?	0	0
<i>Leucozonella</i>	?	0	0	1	0	1	0	?	0	0	0	?	?	0	5
<i>Microxeromagna</i>	0	1	1	0	0	0	0	1	0	0	0	1	1	0	4
<i>Nanaja</i>	?	0	0	1	1	?	0	?	0	2	0	1	?	0	6
<i>Plicuteria</i>	?	0	0	0	0	?	0	?	0	1	0	?	?	0	0
<i>Pseudoxerophila</i>	0	1	0	1	0	1	1	1	0	0	0	?	?	0	?
<i>Trichia</i>	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
<i>Xerolenta</i>	0	1	0	1	2	1	1	1	0	0	0	1	0	0	6
<i>Xeromunda</i>	0	1	1	1	2	?	1	1	0	0	0	1	0	0	6
<i>Xerosecta</i>	0	1	1	0	0	1	0	1	0	0	0	1	0	0	2
<i>Xerotricha</i>	0	1	0	1	1	1	0	1	0	2	0	1	1	0	?

two pairs of stylophores disposed on opposite sides of vagina, each pair consisting of a smaller inner and a larger outer stylophore; outer stylophore containing slightly curved darts of circular section near base and oval or rhombic section thereafter; each inner stylophore (called "accessory sacs" by Nordsieck, 1987, and Hausdorf, 1988; see Giusti & Manganelli, 1989: 51, for a discussion of homology and terminology of this structure) showing wide, totally dartless internal cavity; cavities of outer and inner stylophore of each couple in communication and opening into vagina in a single opening bordered by two large anteriorly fused pleats. Digitiform glands forming two groups, each of two glands, sometimes apically branched, arising from opposite sides of distal vagina close to point where bursa copulatrix duct arises. Bursa copulatrix duct of medium length, with initial portion slightly flared. Penial complex with flagellum almost as long as epiphallus plus penis. Epiphallus (from end of vas deferens to point of attachment of penial retractor) long, almost twice penis length. Penis (from point of attachment of penial retractor to genital atrium) lacking distinct penial sheath and distally enlarged. Wide area yellow in colour and covered with glandular tissue, on external side of terminal portion of penis walls. Pe-

nial papilla cylindrical, formed by a wide tube with thin walls. Penial papilla lumen continuous with that of proximal penis and epiphallus. T-shaped (in transverse section) pilaster running entire length of penial papilla and joined to it by a peduncle, so that cross section of papilla plus pilaster resembles card figure spades.

Right ommatophore retractor free of penis and vagina.

Penial nerve apparently arising in the right cerebral ganglion (according to Franc, 1968: 473, even if it comes from cerebral ganglion the penial nerve originates in the pedal ganglion).

#### Origin of the Name

*Helicotricha*, gender feminine.

The small helicoid shell with hairy periostracum suggested the name of the new genus.

#### Type species

*Helicotricha carusoi* n. sp.

*Helicotricha carusoi* n. sp.

[Figs. 1A-C, 2A-D, 3A-D, 4A-D, 5A-D, G, 6A-C]

*Helicella (Xerotricha) conspurcata*,—Giusti, 1973: 259–260 [partim, non Draparnaud, 1801].



FIG. 1. Shells of *Helicotricha carusoi* n. gen. n. sp. Holotype (A) and one paratype (B) from Alicudi Island: Perciato, F. G. leg. 24.10.69. A shell from Salina Island: Pollara, R. Arcidiacono leg. 21.9.66 (C).

*Helicopsis* sp.,—Piantelli et al., 1990: Table 5 et passim.

#### Diagnosis

At present the only species of the genus *Helicotricha* known. Specific coincides with generic diagnosis.

#### Description

*Shell* (Figs. 1A–C, 2A–D): Shell small (Figs. 1A–C), hairy, low conical above, convex below, opaque brown in colour, with white flecks.

White flecks widely distributed over shell surface, concentrated above (near sutures and near periphery of last whorl) to form irregularly spaced spots of variable shape, below (from periphery of last whorl to umbilicus) to form white spiral bands of variable width and number (2–6). Spire depressed-conical, consisting of 4–4½ convex, regularly increasing whorls separated by deep sutures; last whorl angled at periphery, dilated, sometimes descending slightly near aperture. Umbilicus open and wide, approximately 1/5 of maximum shell diameter. Aperture markedly oblique, oval, lack-

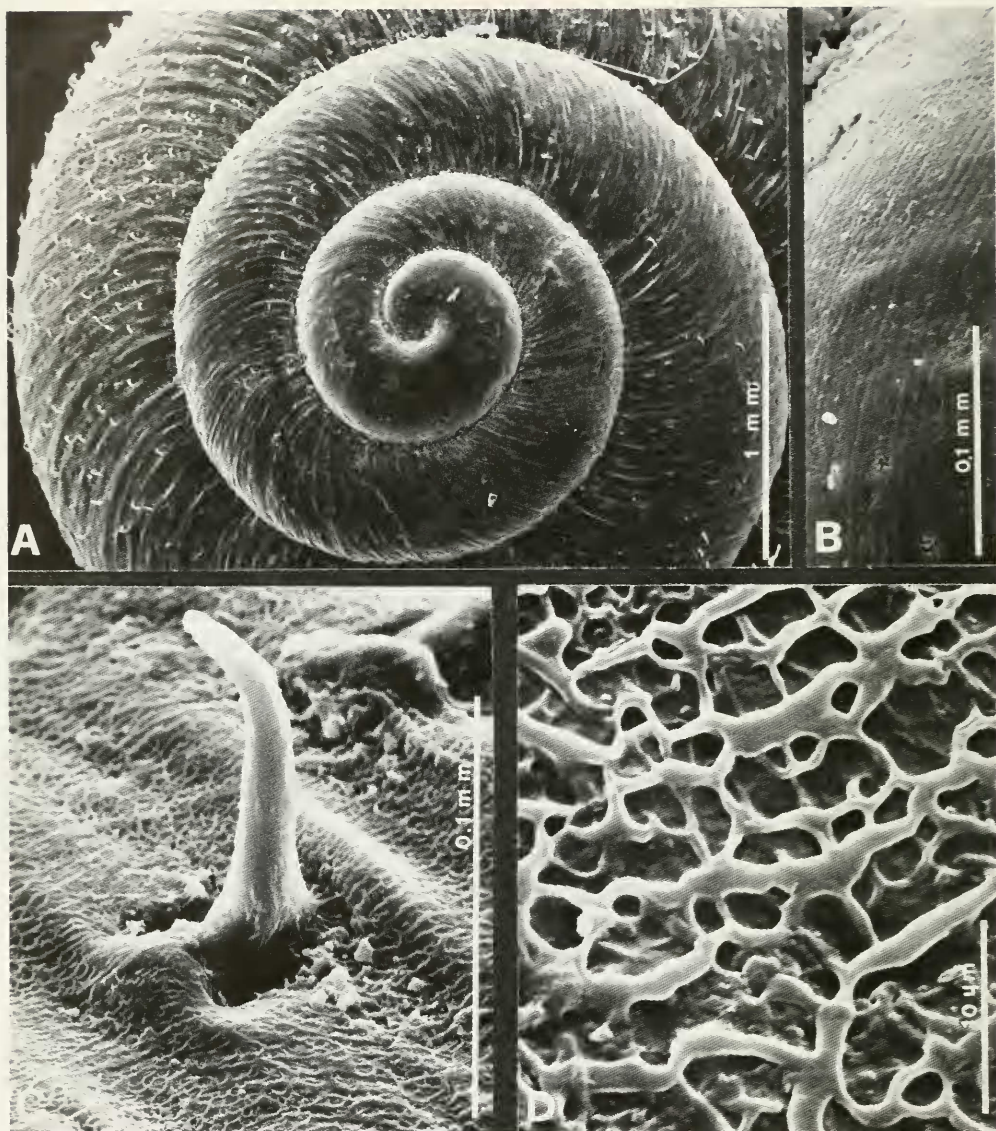


FIG. 2. External shell surface of specimens of *Helicotricha carusoi* n. gen. n. sp. collected on Panarea Island, D. Caruso & I. Marcellino leg. 27.5.67 (A–B) and Lipari Island: Monte Sant'Angelo, F.G. leg. 23.10.69 (C–D). A: A view of first whorls. B: Detail of protoconch showing longitudinal grooves. C: Detail of last whorl with one hair and reticular microsculpture of teleoconch. D: Detail of reticular microsculpture of teleoconch.

ing internal rib; peristome not thickened, slightly reflexed at its columellar margin.

External surface of protoconch with few faint growth lines near its end (Fig. 2A) and microsculpture consisting of fine close spiral grooves (Fig. 2B). External surface of teleoconch (Fig. 2A) with many growth lines, more marked near sutures. Periostracal layer (Fig.

2C–D), superficially reticulated (Fig. 2D) to form transverse rows of very short, often hook-shaped hairs 0.1 mm in length (Fig. 2C). Reticulation and hairs of caducous appearance, absent in large portions of surface. Surface of mineralized portion of shell (in areas devoid of periostracal layer) seems to be crossed by fine close spiral grooves.



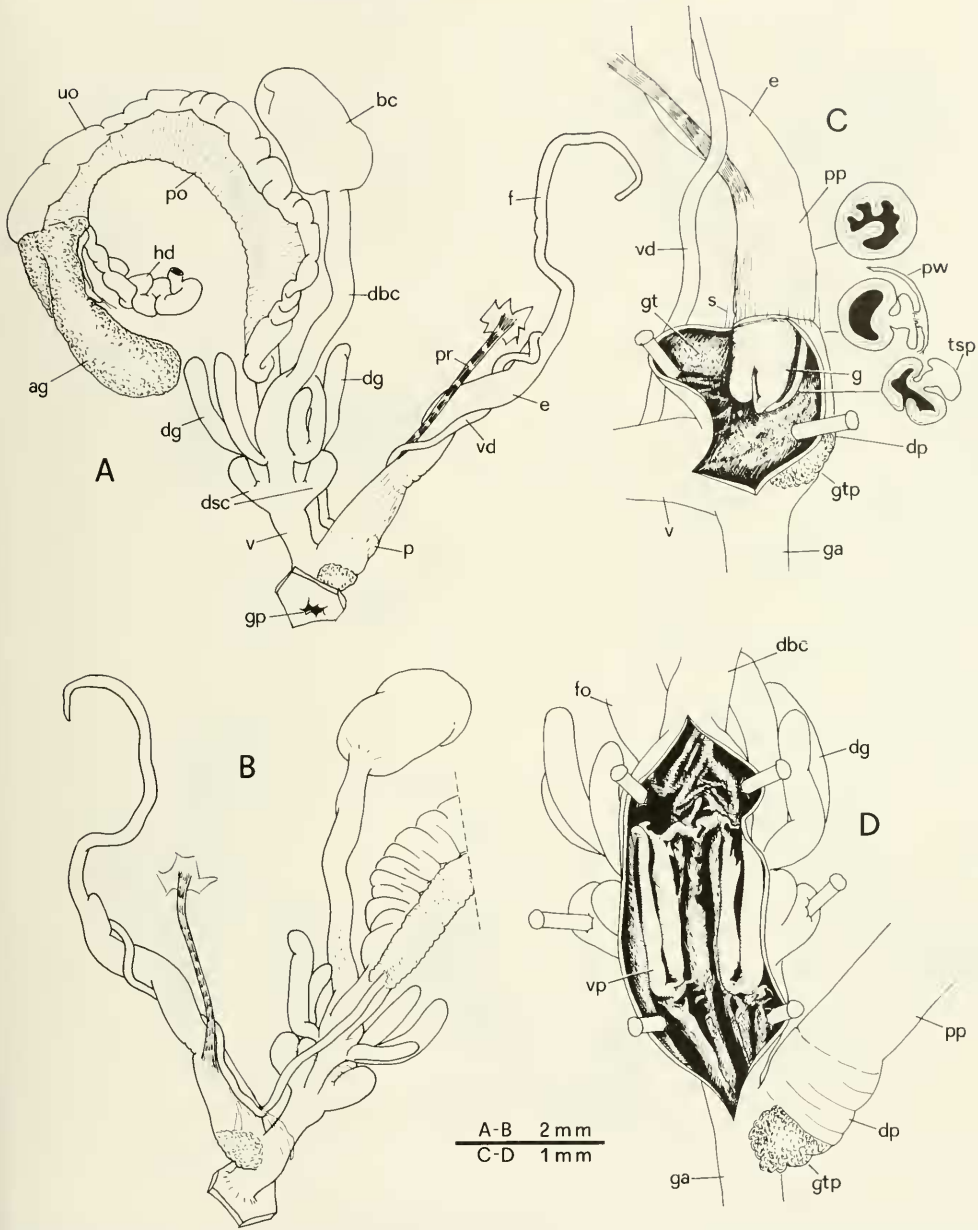


FIG. 3. Genitalia of *Helicotricha carusoi* n. gen. n. sp. in specimens collected on Basiluzzo Islet, F. G. leg. 5.11.69. A-B: Two opposite views of the same genital apparatus (gonad excluded in A; gonad and part of ovispermiduct excluded in B). C: Part of penial complex with distal penis opened to show penial papilla, a section of proximal penis and two sections of penial papilla. D: Vagina opened to show its inner structure. Explanations of the symbols used in Figures 3-5, 8: ag, albumen gland; bc, bursa copulatrix (gametolytic gland); dbc, duct of bursa copulatrix; dg, digitiform glands; dsc, dart-sac complex; dp, distal penis; e, epiphallus; f, flagellum; fc, fertilization chamber; fn, fenestration; fo, free oviduct; fr, frenula; g, penial papilla (glans); ga, genital atrium; gp, genital pore; gt, glandular tissue; gtp, gland of the terminal penis; hd, hermaphrodite duct; p, penis; po, prostatic portion of ovispermiduct; pp, proximal penis; pr, penial retractor muscle; pv, proximal vagina; pw, penial wall; s, stripes; sr, seminal receptacle; t, talon; tsp, t-shaped pilaster of the penial papilla; uo, uterine portion of ovispermiduct; v, vagina; vd, vas deferens.

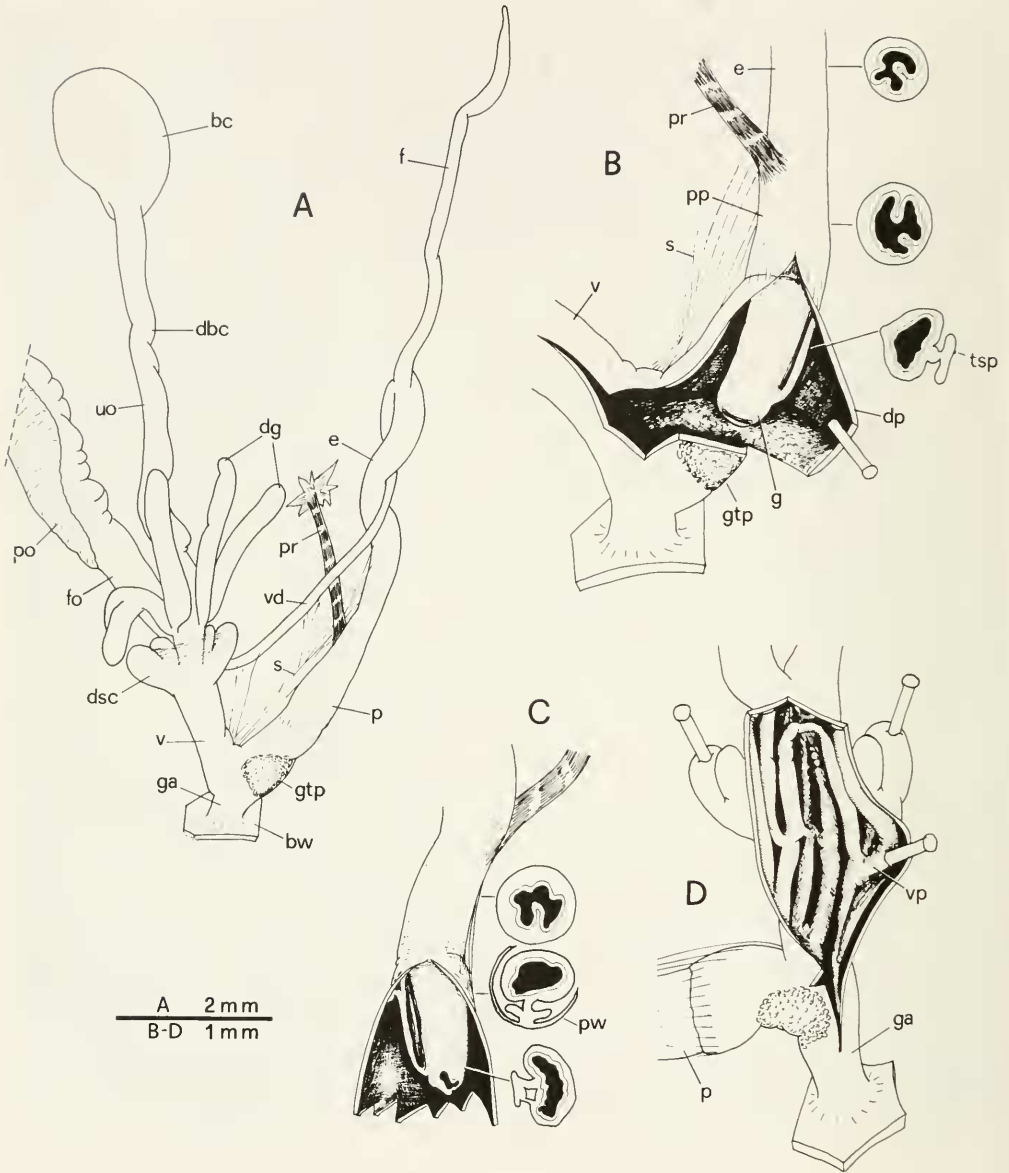


FIG. 4. Genitalia of *Helicotricha carusoi* n. gen. n. sp. in specimens collected on Filicudi Island: Stimpagnato, F. G. leg. 28.10.69. A: Genital apparatus (gonad and part of ovispermiduct excluded). B-C: Part of two penial complexes with distal penis opened to show penial papilla, section of epiphallus, proximal penis and penial papilla (B), Section of proximal penis and two sections of penial papilla (C). D: Vagina opened to show its inner structure.

Dimensions (N = 10): shell max. diam.: 4.5–5.4 mm; shell height: 2.5–3.4; aperture max. diam.: 2.0–2.5 mm; aperture height: 1.7–2.1.

Dimensions of the holotype: shell max.

diam.: 5.3 mm; shell height: 2.8; aperture max.: diam. 2.1 mm; aperture height: 2.1

*Genitalia* (Figs. 3A–D, 4A–D, 5A–D, G): Convoluted first hermaphrodite duct arising from

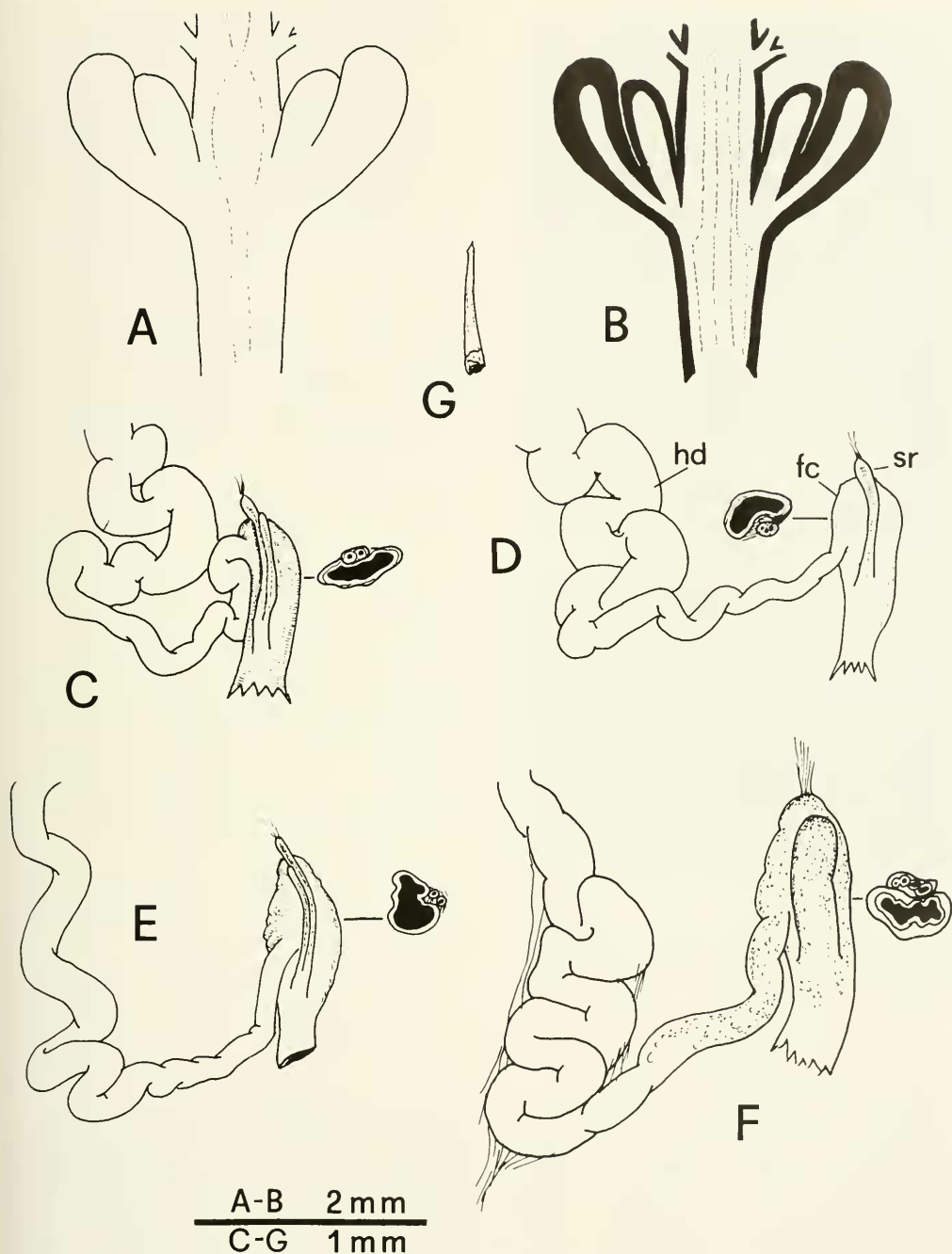


FIG. 5. Outline and scheme of dart-sac complex (darts omitted) (A-B), talon (C-D) and dart (G) of *Helicotricha carusoi* n. gen. n. sp. in specimens collected on Filicudi Island: Stimpagnato, F. G. leg. 28.10.69, talon (E) of *Microxeromagna armillata* from Corsica: Olmeto, F.G. & G.M. leg. 1.12.83 and talon (F) of *Helicopsis striata* from Öland, parish Persnäsa (Jordhamn, Sweden).

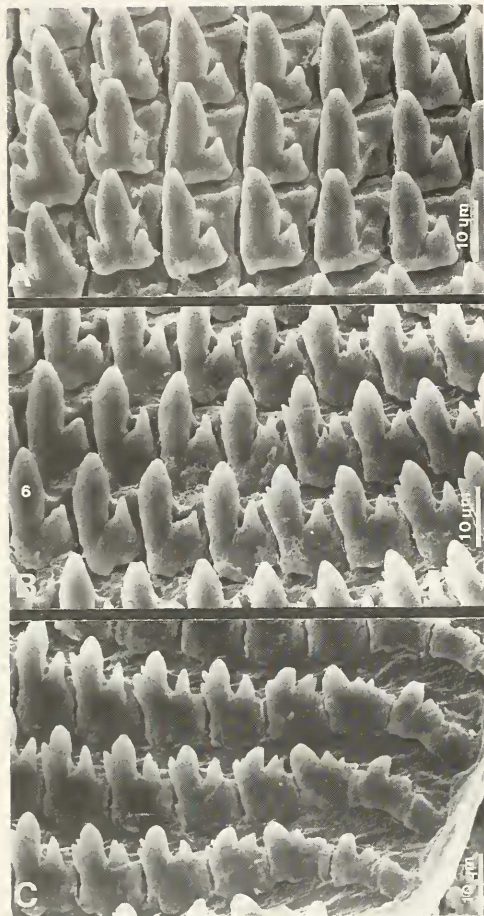


FIG. 6. Radula of *Helicotricha carusoi* n. gen. n. sp. in a specimen collected on Basiluzzo Islet, F. G. leg. 5.11.69. A: Central tooth and first lateral teeth. B: 6th–12th lateral teeth. C: Extreme marginal teeth.

multilobate gonad (not illustrated) and ending in talon (i.e. fertilization chamber plus seminal receptacle complex); talon lying on surface of inner side of large albumen gland. Talon (Fig. 5C–D) with wide lateral fertilization chamber embracing basal portion of seminal receptacle complex. Receptacle complex very slender, only slightly enlarged apically and containing 2–3 very small distinct sperm tubes. Ovispermiduct wide, plurilobate, consisting of prostatic and uterine portions. Prostatic portion continuing anteriorly into vas deferens and proximal portion of penis complex. Penis complex (Figs. 3A–B, 4A) consisting of penial

flagellum, epiphallus (i.e. from end of vas deferens to point of attachment of penial retractor muscle) and penis (i.e. from point of attachment of penial retractor muscle to genital atrium). Penial flagellum long (4.9–5.5 mm;  $N = 3$ ) and slender along entire length. Epiphallus longer (3.0–4.0 mm;  $N = 3$ ) than penis (2.0–2.3 mm;  $N = 3$ ) and narrower. Penis lacking distinct penial sheath but with thin bands of tissue arising where penial retractor muscle ends and terminating near penis end. Penis distally enlarged where it contains penial papilla (= glans). Wide area yellow in colour and covered with glandular tissue (also evident internally) on external side of terminal portion of penis walls. Penis walls level with base of penial papilla sometimes appear to contain glandular tissue. Penial papilla (Figs. 3C, 4B–C) cylindrical, consisting of a wide tube. Penial papilla lumen continuous with proximal penis and epiphallus. T-shaped (in transverse section) pilaster running alongside penial papilla for entire length, joined to it by a peduncle. Ejaculatory pore at apex of penial papilla, slit-like, variable in width. T-shaped pilaster basally connected to penis wall for short distance at penial papilla base (Figs. 3C, 4C). Penial retractor muscle usually short. Uterine portion of ovispermiduct continuing anteriorly into short (approximately 1 mm;  $N = 3$ ), wide uterine canal (i.e. free oviduct) ending in vagina level with point of entry of duct (4–6 mm in length;  $N = 3$ ) of bursa copulatrix. Bursa copulatrix (i.e. gametolytic gland) (Figs. 3A–B, 4A) sac-like and variable in shape. Duct of bursa copulatrix 4–6 mm long ( $N = 3$ ), its initial portion slightly flared, internally figured with series of fine pleats. Dart-sac complex consisting of two pairs of stylophores, each pair consisting of a smaller inner dartless stylophore and a larger outer dart-bearing stylophore. Opening of each pair of stylophores clearly visible half way along vagina on opposite sides (Figs. 3A–B, 4A, 5A–B). Two pairs of digitiform glands also opening on opposite sides of proximal vagina close to dart-sac complex. Digitiform glands irregular in shape and sometimes apically bifurcated. Each digitiform gland and dart-sac pair opens into the vagina within a furrow laterally bordered by two large, distally fused folds (Figs. 3D, 4D). Other smaller folds run longitudinally on the internal vagina walls between two systems of larger folds. All folds taper distally to end on internal genital atrium walls. Dart of each outer stylophore very small (1 mm in length;  $N = 2$ ), basally circular

in transverse section, apically flattened-oval or rhombic, tip arrowhead-shaped (Fig. 5G).

*Other Anatomical Characters:* Penial nerve apparently originating in right cerebral ganglion (according to Franc, 1968: 473, even if it comes from cerebral ganglion the penial nerve originates in the pedal ganglion).

Right ommatophore retractor independent of penis and vagina (i.e. not passing between the penis and vagina).

*Radula* (Fig. 6A–C): Radula consisting of many rows of teeth each according to formula 20–22 + C + 20–22. Central tooth with wide basal plate and raised pointed upper vertices. Body of tooth with very large mesocone and two small ectocones, 1/3 of mesocone length. First lateral teeth having wide basal plate but with inner vertex missing; body with large pointed mesocone and small pointed ectone 1/4 of mesocone length. At about 6th or 7th lateral tooth, inner side of mesocone showing slight protuberance developing into pointed cusp in following lateral and marginal teeth. Moving laterally, teeth maintaining same shape but progressively smaller, with more pointed cusps and reduced basal plates. Last marginal teeth having mesocone apex with 2–3 cusps and ectotone split into 2–4 smaller points.

*Jaw:* Jaw odontognathous, strongly ribbed and devoid of central denticle.

#### Type Locality

Aeolian Islands, Alicudi Island: Perciato [UTM references: 33SVC4465].

#### Typical Series

Holotype (shell) (Fig. 1A) and 7 paratypes (2 shells + 3 dissected specimens + 2 spirit specimens) from the type locality, F. G. leg. 24.10.69. Holotype and all the paratypes in Giusti Collection, Dipartimento di Biologia Evolutiva, Università degli Studi di Siena, Via Mattioli 4; I-53100 Siena, Italy. Other material examined (all from Aeolian Islands [UTM ref.: 33SVC, WC])

Alicudi Island [33SVC46]: Spano [4467], F. G. leg. 26.10.69 (2 spirit specimens + 2 dissected specimens).

Basiluzzo Islet [33SWC07]: S. Bruno leg.

25.2.67 (7 spirit specimens), F. G. leg. 5.11.69 (1 spirit specimen + 1 dissected specimen); F. G. leg. 31.3.71 (3 spirit specimens).

Filicudi Island [33SVC66, 67]: Siccagni [6070], F. G. leg. 29.10.69 (1 spirit specimen); Stimpagnato [6168], F. G. leg. 28.10.69 (4 spirit specimens + 2 dissected specimens); Between Canale and Monte Guardia [6268, 6368], F. G. leg. 28.10.69 (3 spirit specimens); Zucco Grande [6270, 6370], F. G. leg. 30.10.69 (2 spirit specimens + 1 shell), F. G. leg. 23.3.72 (2 shells).

Lipari Island [33SVC95, 96]: G. Marcuzzi leg. 13.4.68 (1 shell + 1 spirit specimen); Capistello [9556, 9656], F. G. leg. 27.4.70 (1 shell); Monte Sant'Angelo [9360, 9460], F. G. leg. 23.10.69 (5 shells).

Lisca Bianca Islet [33SWC07]: F. G. leg. 5.10.69 (7 spirit specimens)

Panarea Island [33SWC07]: D. Caruso & I. Marcellino leg. 27.5.67 (5 shells), Punta del Corvo [0576], F. G. leg. 30.3.71 (1 shell + 1 spirit specimen); Punta Milazzese [0575], F. G. leg. 5.11.69 (1 spirit specimen + 1 dissected specimen).

Salina Island [33SVC86, 87]: Capo Faro [8870], F. G. leg. 25.4.70 (2 spirit specimens); Lingua [8865], F. G. leg. 25.4.70 (2 spirit specimens + 1 dissected specimen); Malfa [8570], R. Arcidiacono leg. 17.9.66 (1 spirit specimen); Monte dei Porri [8368, 8468], F. G. leg. 26.4.70 (3 spirit specimens); Pollara [8369], R. Arcidiacono leg. 21.9.66 (1 shell), F. G. leg. 25.4.70 (1 spirit specimen); Rinella [8566], F. G. leg. 26.4.70 (1 shell); Valle del Santuario [8568], F. G. leg. 25.4.70 (1 spirit specimen).

Stromboli Island [33SWC19, 20]: G. Marcuzzi leg. 16.4.68 (28 spirit specimens).

Vulcano Island [33SVC95]: G. Marcuzzi leg. 12.4.68 (2 shells); Porto [9652], F. G. leg. 27.4.70 (2 spirit specimens + 1 shell).

All the material in Giusti Collection, Dipartimento di Biologia Evolutiva, Università degli Studi di Siena, Via Mattioli 4; I-53100 Siena, Italy.

Locality names and UTM references based on the Official Map of Italy 1:25.000 Series M 891.

#### Origin of the Name

The new species is dedicated to Prof. Domenico Caruso, Director of the Department of Animal Biology, University of Catania, Italy, in token of highest esteem and companionship.

## DISCUSSION

## Generic Status

As outlined in the introduction, the supraspecific status of the new species was difficult to establish. Some anatomical features (2 + 2 stylophores and right ommatophore retractor independent of penis and vagina) suggested relationships with more than one genera of Hygromiidae found in the western Mediterranean and Europe: *Xerotracha* Monterosato, 1892 (type species: *Helix conspurcata* Draparnaud, 1801), *Helicella* Férussac, 1821 (type species: *Helix itala* Linnaeus, 1758) and *Helicopsis* Fitzinger, 1833 (type species: *Helix striata* Müller, 1774) (see Gittenberger, 1969; Gittenberger & Manga, 1977; Schileyko, 1978a; Gittenberger & Raven, 1982; Giusti & Manganelli, 1989; Gittenberger et al., 1989; Hausdorf, 1988).

Following the scheme of classical evolutionary systematics a first comparison was made with *Xerotracha*, the type species of which, *X. conspurcata* (Draparnaud, 1801), has a small hairy shell that differs from *Helicotracha carusoi* n. sp. only by virtue of its longer periostracal hairs and its narrower umbilicus.

*Xerotracha conspurcata*, like both its congeneric species, *X. apicina* (Lamarck, 1822) and *X. nubivaga* (Mahille, 1882) (Hausdorf, 1988; Gittenberger et al., 1989; Giusti & Manganelli, 1989), shows a differently structured vaginal complex characterized by a large dart-sac complex consisting of two pairs of stylophores, each constituted by a larger outer dart-bearing stylophore and a very small inner dartless stylophore (i.e. 2 + 2) (see Giusti & Manganelli, 1989: 51, for a discussion of homology and terminology of these structures). The latter open into the vagina inside the slit delimited by two large tongue-like structures that are apically independent of each other (Hausdorf, 1988: fig. 9; Giusti & Manganelli, 1989: figs. 3, 5, 9A–B). The penial papilla in *Xerotracha* is also different, being simple and without lateral pilaster (Giusti & Manganelli, 1989: figs. 2D, 4E).

Anatomically the new species is also similar to some small *Helicella* with shells that have persistent postembryonic hairs (e.g. *H. corderoi* Gittenberger & Manga, 1977—see Gittenberger & Manga, 1977; Manga Gonzales, 1983; *H. mangae* Gittenberger & Raven, 1982—see Gittenberger & Raven, 1982; according to Prieto, 1986, this nominal species

is a junior synonym of *H. gonzalei* Azpeitia, 1924). Nevertheless, *Helicella* has a dart-sac complex which, although similar (consisting of two opposite pairs of stylophores, each formed by a very large apically pointed outer stylophore and a very reduced, almost vestigial, inner dartless stylophore, i.e. 2 + 2), opens internally into a continuous pleated tube-like structure contained in the vagina (Hausdorf, 1988: fig. 8; Giusti & Manganelli, 1989: figs. 6A,E, 7, 9C). In *Helicella*, the penial papilla is also different, being simple and without lateral pilaster (Hausdorf, 1988: fig. 8; Giusti & Manganelli, 1989: fig. 6F).

Detailed comparison was then made with *Helicopsis*<sup>4</sup>, the species of which have a very similar genital scheme (Hesse, 1934; Gittenberger, 1969; Damjanov & Likharev, 1975; Schileyko, 1978a; Grossu, 1983; Giusti & Manganelli, 1989; present paper: Figs. 5F, 8A–C). *Helicopsis* (s. str.) has so far been identified with certainty only in central and oriental Europe, and subgenus *Xeroleuca* Kobelt, 1877 (type species: *Helix turcica* Holten, 1802) has been reported in northwestern Africa (Hesse, 1934; Zilch, 1960). There are two records of *Helicopsis* (s. str.), one in Tunisia (Ktari & Rezig, 1976) and one at Huelva, Spain, (Gasull, 1972, 1985) that must be checked. The species briefly studied by Ktari & Rezig (1976) may correspond to a species found by one of us in Morocco (Figs. 7A, 8A–C). *Helicopsis* (s. str.) has a small, thick, robust, ribbed and hairless shell and a vagina with a dart-sac complex constituted by two opposite pairs of stylophores, each formed by an outer and an inner stylophore (i.e. 2 + 2). The outer stylophores are smaller and more slender than those in *Xerotracha* and *Helicella* and are more clearly distinguished from the inner dartless stylophores which, in their turn, are larger than those in *Xerotracha* and *Helicella*. Moreover, the vagina in *Helicopsis* is clearly different from that in *Xerotracha* and *Helicella*, being internally devoid of tongue-like or tube-like structures into which the stylophores open (Giusti & Manganelli, 1989: figs. 8C, 9D). In view of the above and because the new species and those of *Helicop-*

<sup>4</sup>While the paper was in press, Hausdorf (1990b) described the genitalia of three species-group taxa supposed to belong to genus *Helicopsis*: *H. gittenbergeri* n. sp., *H. s. subcalcarata* (Naeglele, 1903) and *H. subcalcarata neuberti* n. subsp. Comparison with the latter taxa has been omitted because no information about the penial papilla structure, the only sure diagnostic character for *Helicopsis*, was furnished.

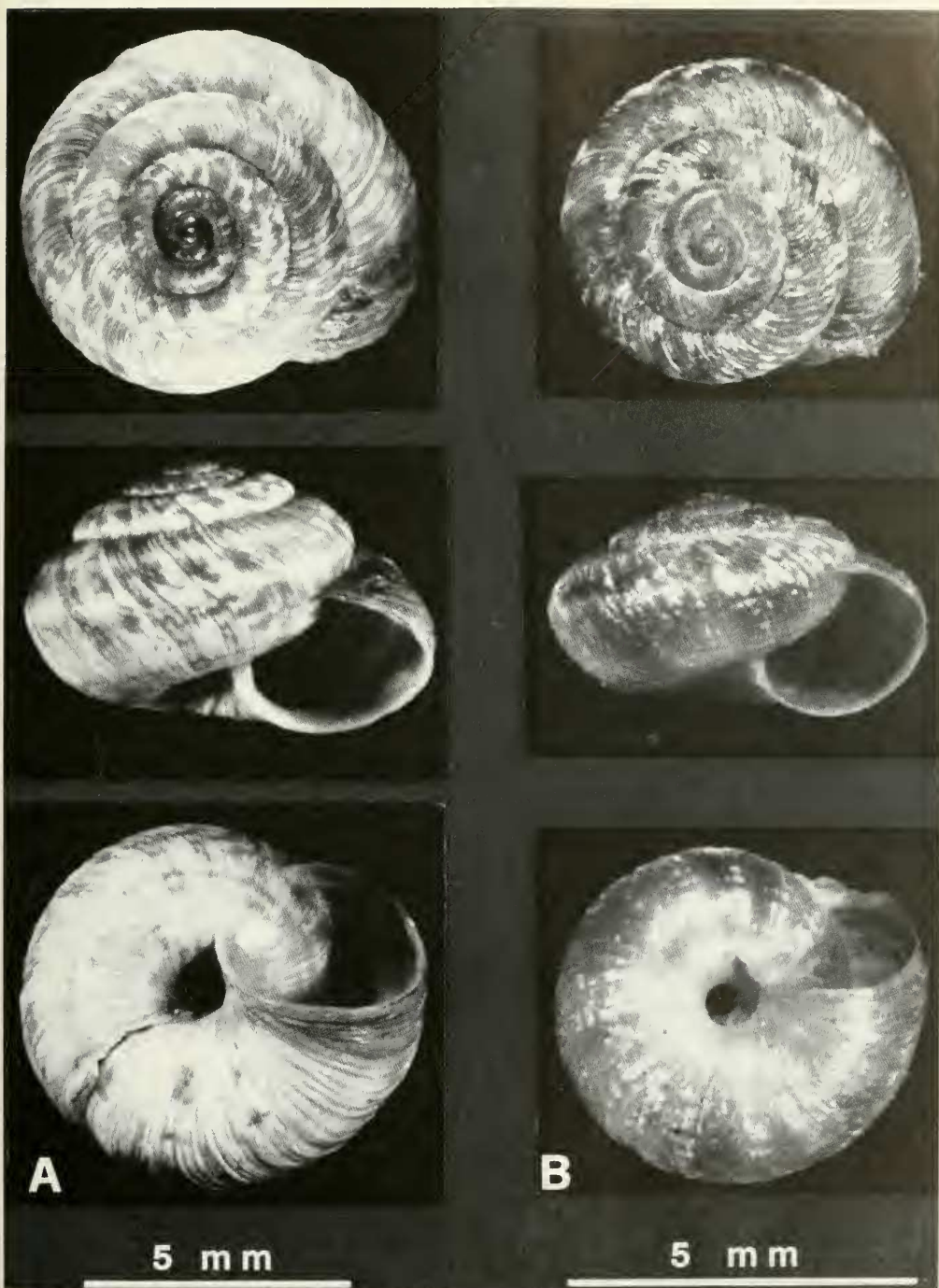


FIG. 7. A: Shell of *Helicopsis* sp. collected at the foot of Mount Zerboum, Moulay Idris (Morocco). B: Neotype of *Helix aetnea* Benoit, 1857, Nicolosi sull'Etna, C. Caroti leg. 1877 (Museum of Zoology, University of Florence, Italy, MZUF no. 5049/1).

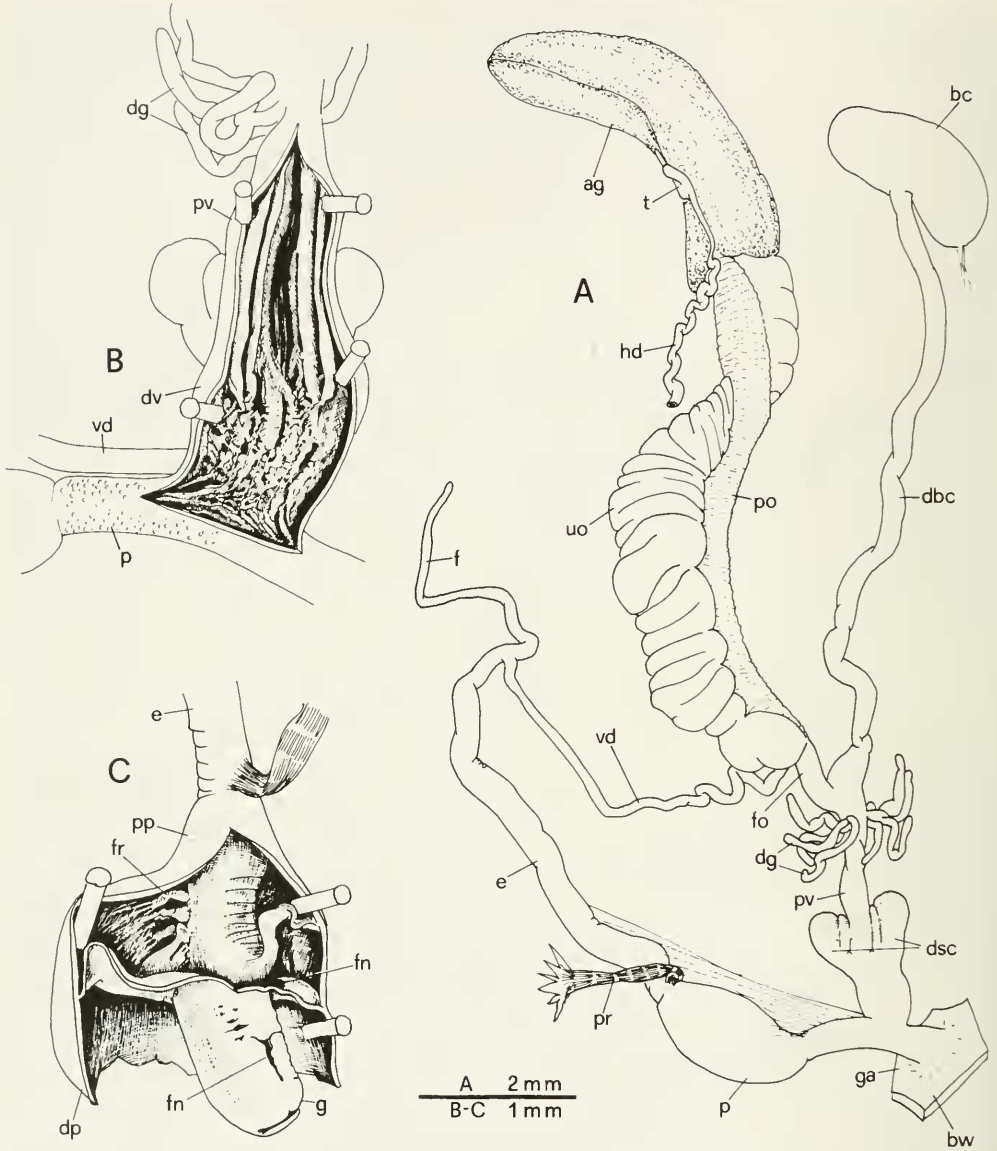


FIG. 8. Genitalia of *Helicopsis* sp. in specimens collected at the foot of Mount Zerboum, Moulay Idris (Morocco). A: Genital apparatus (gonad excluded). B: Vagina opened to show its inner structure. C: Part of the penial complex with the penis opened to show the penial papilla.

*sis* (Schileyko, 1978a: fig. 237; Giusti & Manganeli, 1989: fig. 8C) have stylophores opening in a slit bordered by two large but simple pleats running along the vagina walls, it seems plausible to include the new species in the genus *Helicopsis*. Nevertheless, the structure of the penial complex in the new species differs from that in *Helicopsis*. The

species of the latter genus, about which there is detailed knowledge of genital structure, have a penial papilla consisting of a central tube wrapped in an external sheath that is more or less laterally and basally fenestrated and which basally expands to reach and to fuse with the penial walls (Schileyko, 1978a: figs. 235, 238–242, 244; Giusti & Manganeli,



1989: figs. 8D, F–H; present paper: Fig. 8C). In so doing, the sheath distinguishes the cavity of the distal penis (containing the penial papilla) from that of the proximal penis, although it does not impede communication through its fenestrations. The cavity of the proximal penis is traversed by a tube that has sometimes a lateral pilaster connected by frenula to the penis walls and which is basally continuous with the epiphallus and apically with the central tube of the penial papilla. This peculiar penis structure, present not only in the European species but also in the Maghrebian species studied herein, can be considered diagnostic for *Helicopsis*. Consequently, the present new species cannot be included in the genus *Helicopsis*.

One can argue that the penis structure in the present new species may be derived from that in *Helicopsis* through the reduction of the penial papilla sheath (the lateral T-section pilaster may be a residue of the sheath) and the loss the peculiar inner structure of the proximal penis. However this hypothesis seems less probable than the following one.

*Helicotricha carusoi* n. sp. has a shell clearly resembling in overall structure, microsculpture and colour that of a well-known Mediterranean species: *Microxeromagna armillata* (Lowe, 1852) (Giusti & Manganelli, 1989: pl. 7, figs. A–E). The latter species, moreover, has a genital structure corresponding to that of *H. carusoi* n. sp. (similar talon, similar length and proportions of the parts of the penial complex, a yellow glandular area on distal penis walls; see Ortiz de Zarate Y Lopez, 1950: fig. 22; Forcart, 1976: fig. 3; Clerx & Gittenberger, 1977: figs. 102–103; Falkner, 1981: fig. 2; Aparicio, 1982: fig. 3; Manga Gonzales, 1983: fig. 12; Hausdorf, 1988: fig. 13; Manganelli & Giusti, 1988: figs. 11A–F, 14H; present paper: Fig. 5E). It only differs in the dart-sac complex, which has 0 + 2 stylophores (instead of 2 + 2), and in some details of the penial papilla. Other monophyletic groups have been hypothesized to be formed by genera with 2 + 2 and 0 + 2 stylophores (i.e. *Helicella-Candidula* and *Xerolenta-Xeromunda*; Hausdorf, 1988, 1990a, Giusti & Manganelli, 1989; Manganelli & Giusti, 1989). Similarly, we hypothesize that *Helicotricha* n. gen. forms a monophyletic group with *Microxeromagna*. The former genus can have originated the latter by reduction of the dart-sac complex; the origin of *Helicotricha* from *Microxeromagna* by duplication of the dart-sac complex seems less probable according to Schileyko's (1978a, 1984) recon-

struction of the phylogenetic relationships in the Hygromiidae.

Many other genera of the European and Russian Hygromiidae resemble *Helicotricha* n. gen. in having the vaginal complex with digitiform glands and dart-sac complex constituted by two opposite pairs of stylophores, each formed by a large, dart-bearing outer stylophore and a smaller dartless inner stylophore (i.e. 2 + 2): *Hygrohelicopsis* Schileyko, 1977 (type species: *H. darevskii* Schileyko, 1977), *Leucozonella* Lindholm, 1927 (type species: *Helix rubens* von Martens, 1874), *Kokotschashvilia* Hudec & Lezhawa, 1969 (type species: *Helix holotricha* Boettger, 1874), *Caucasigena* Lindholm, 1927 (type species: *Helix eichwaldi* Pfeiffer, 1846), *Plicuteria* Schileyko, 1977 (type species: *Helix lubomirskii* Slosarski, 1881), *Trichia* Hartmann, 1840 (type species: *Helix hispida* Linnaeus, 1758), and *Edentiella*, Polinski, 1929 (type species: *Helix edentula* Draparnaud, 1801) (see Schileyko, 1978a, 1978b). Of these, the genus closest to *Helicotricha* n. gen. is *Hygrohelicopsis* because it shows the right ommatophore retractor independent of penis and vagina. Nevertheless, *Hygrohelicopsis* can be easily distinguished by the structure of distal genitalia showing inner stylophores extremely reduced, not visible from outside, distal vagina absent, and penial papilla bulbous but simple without external sheath or lateral pilaster. All the other genera are more distinguished from *Helicotricha* n. gen. because they have the right ommatophore retractor passing between penis and vagina, different and larger shells, different penial papillae and many other minor differences in the structure of the genitalia (Schileyko, 1978a, 1978b).

#### Cladistic Analysis

The entire set of character states (Table 2) utilized in the traditional approach was used for cladistic analysis. The latter was attempted even if the characters were few and limited to genitalia structure. To avoid complicating the analysis, only a limited number of eastern European genera was considered: those for which better description exist and which are at least apparently more closely related to the new genus.

A total of 105 most parsimonious hypotheses were generated by our data matrix. All have 37 steps with a consistency index of 0.67 and rescaled retention index of 0.72 after non-informative characters were excluded.

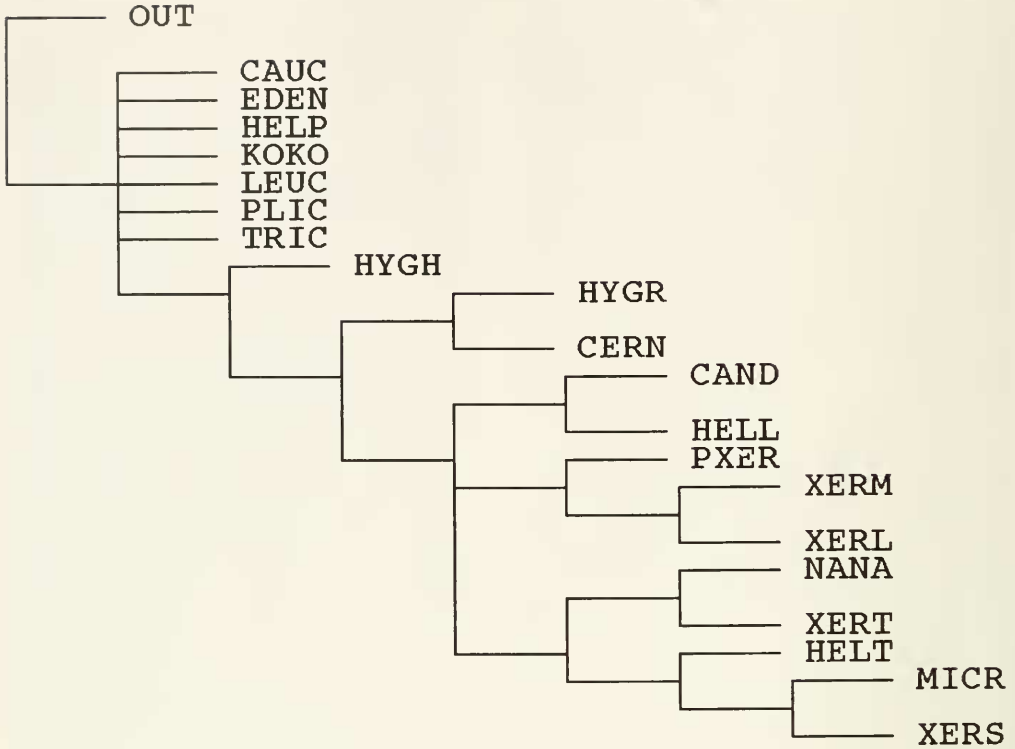


FIG. 9. The Nelsen consensus tree of 105 cladograms.

The successive weighting procedure did not discriminate among them, the main difference being the position of the set of taxa HELP-LEUC. The Nelsen consensus tree of 105 cladograms (Fig. 9) showed that 11 monophyletic groups appear in all of them, listed with their synapomorphies as follows:

- (1) All the taxa, except HELP, TRIC, KOKO, PLIC, CAUC, EDEN, LEUC: 2 (1) (parallel with HELP and a reversion in HYGM).
- (2) All the taxa, except HELP, TRIC, KOKO, PLIC, CAUC, EDEN, LEUC, HYGH: 15 (6).
- (3) HYGM, CERN: 3 (1), 9 (1), 10 (4) (the first parallel with CAND, XERM, MICR, XERS).
- (4) CAND, HELL, PXER, XERL, XERM, XERT, NANA, HELT, MICR, XERS: 8 (1) (parallel with HELP, TRIC).
- (5) CAND, HELL: 1 (1), 5 (4), 10 (3) (the first parallel with CERN).
- (6) PXER, XERL, XERM: 7 (1).
- (7) XERL, XERM: 5 (2).
- (8) XERT, NANA, HELT, MICR, XERS: 13 (1) (with a reversion in XERS).
- (9) XERT, NANA: 5 (1), 10 (2).
- (10) HELT, MICR, XERS: 4 (0), 15 (2) (the former is a reversion).
- (11) MICR, XERS: 3 (1) (parallel with HYGM, CERN, CAND, XERM).

Character 6 represented a synapomorphy for the entire set of terminal taxa with a reversion in MICR. Figure 10 is one of the 105 minimum-length trees. It is not a preferred tree and is simply given to illustrate the evolution of the characters.

As is evident, the main result of cladistic study has been that of apparently supporting the conclusion reached in the preceding paragraph, i.e. that *Helicotricha* is a sister group of *Microxeromagna-Xerosecta*. It also appeared to confirm that *Helicotricha* is not closely related to *Helicopsis* as hypothesized in the same paragraph.

Relationships with *Xerosecta* suggested by cladogram seem logical: *Xerosecta* is very

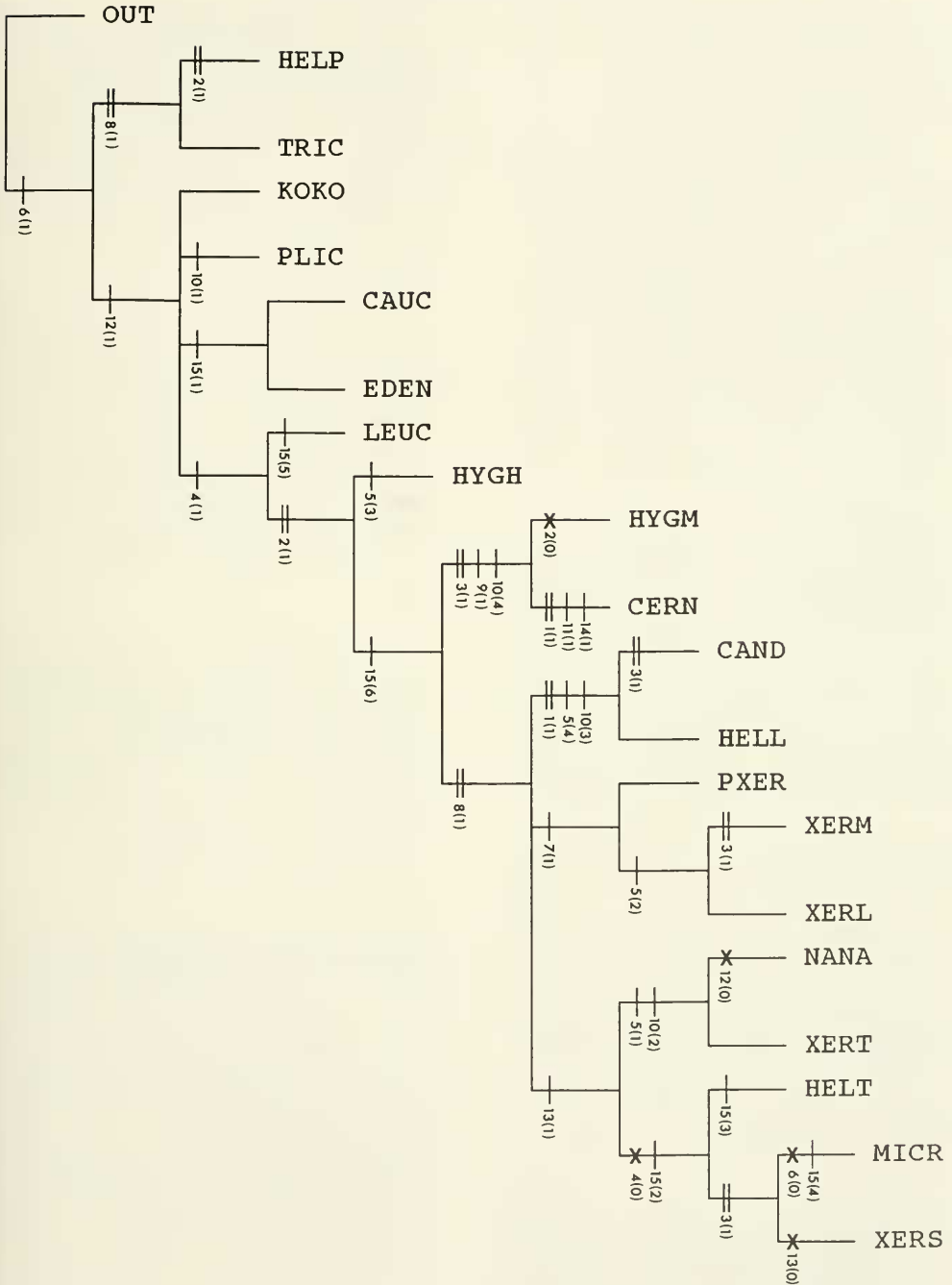


FIG. 10. One of the most parsimonious trees generated by the data matrix given by way of illustration of the evolution of the characters (lines: synapomorphies; double lines: homoplasies; X reversions).

close to *Microxeromagna* (Hausdorf, 1988, 1990c; Manganelli & Giusti, 1988).

#### The Suprageneric Systematics of the Hygromiidae

The phylogenetic hypothesis concerning *Helicotricha* n. gen. formulated above, in addition to those concerning *Xerolenta-Xeromunda* and *Helicella-Candidula*, disagrees with Schileyko's proposal to distinguish the Trichiinae (hygromiids with 2 + 2 stylophores) from the Hygromiinae (hygromiids with 0 + 2 stylophores).

The present data supports the idea that the supposed members of one of these "subfamilies" independently evolved from supposed members of the other so that their derived status is due to parallelism (Giusti & Manganelli, 1987).

The consideration of a larger number of characters, when eventually available (genetic, cytological, etc.) could promote better understanding of the phylogeny of Hygromiidae (and Helicoidea in general) and verify the contention of Giusti et al. (1991) who, on the basis of spermatozoa fine morphology, suggested there are too many family group categories in the Helicoidea and that it is inopportune to produce new schemes and create new taxa on the basis of old and insufficient anatomical (or even shell!) characters.

#### Comparison with Old and Uncertain Taxa of the Species Group

A search of the taxa described for Sicilian fauna did not produce positive results. Apart from *Xerotracha conspurcata*, *X. apicina* and the two species recently revised by us and recognized to belong to a distinct genus—*Schileykiella*: *S. reinae* Pfeiffer, 1856, and *S. parlatoris*, Bivona, 1839 (Manganelli et al., 1989)—only one small hygromiid with a hairy shell, *Helix aetnea* Benoit, 1857, is known in Sicily.

Some shells were found in the Paulucci Collection which, according to the label, were collected in the type locality of *H. aetnea*, studied by Benoit himself, and confirmed by him to fully correspond to his *H. aetnea* (Museum of Zoology, University of Florence, Italy, MZUF no. 5049). Our study of the minute shell characters confirms Paulucci's (1878: 6, 32) and Westerlund's (1889: 302) identification of *H. aetnea* as a juvenile of *X. conspurcata*. Because Benoit's typical series is un-

traceable and there is no other possible typical material in the principal malacological collections, and because Benoit clearly confirmed that Paulucci's material totally corresponded to his species, we have selected a neotype for this species (MZUF no. 5049/1) illustrated in Figure 7B. *Helix aetnea* Benoit, 1857, consequently becomes a junior synonym of *X. conspurcata*.

#### Geographic Distribution

All the Aeolian Islands. A few shells from the island of Ustica (NW of Sicily) [UTM ref.: 33SUC38, 48] may belong to the new species, but since they are sexually immature and anatomical study is impossible, no conclusions can be drawn. Although its presence in Sicily is highly probable, a search of the literature and of our materials from Sicily, and some Sicilian and Maltese Islands did not bring to light any useful information.

#### Ecology

*Helicotricha carusoi* n. sp. has been found to live under stones, dry leaves and pieces of wood in many different places on single islands, frequently together with *Xerotracha conspurcata*. Like the latter species, the present species is thus a xeroresistant element, well adapted to Mediterranean habitats.

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#### LITERATURE CITED

- APARICIO, M. T., 1982, Observations on the anatomy of some Helicidae from central Spain. *Malacologia*, 22 (1-2): 621-626.  
 BENOIT, L., 1857, *Illustrazione sistematica critica iconografica de' testacei estramarini della Sicilia*

- Ulteriore e delle isole circostanti*. i-xvi + 1-52 (+ 1-9 pls. ?), Napoli.
- CLERX, J. P. M. & E. GITTENBERGER, 1977, Eniger über *Cernuella* (Pulmonata, Helicidae). *Zoologische Mededelingen (Leiden)*, 52: 27-56, pls. 1-2.
- DAMJANOV, S. G. & I. LIKHAREV, 1975, Gastropoda terrestria. *Fauna Bulgarica*, 4: 425 pp.
- FALKNER, G., 1981, *Lehmannia valentiana* und *Microxeromagna vestita* bei Grimaldi—neu für die italienische Fauna. *Mitteilungen der Zoologischen Gesellschaft Braunau*, 3: 388-391.
- FARRIS, J. S., 1989, The retention index and the rescaled consistency index. *Cladistics*, 5: 417-419.
- FORCART, L., 1976, Die Cochlicellinae und Helicellinae von Palästina und Sinai. *Archiv für Molluskenkunde*, 106 (4/6): 123-189.
- FRANC, A., 1968, Sous-classe des pulmonés.—In P. P. GRASSE, *Traité de zoologie. Anatomie, systématiques, biologiques*, 5 mollusques gastéropodes et scaphopodes (3): 325-607.
- GASULL, L., 1972, Descripción de una nueva especie de *Helicella* de la provincia de Huelva, *Helicopsis (Helicopsis) altenai* n. sp. (Gastrop. Pulmon.). *Boletín de la Sociedad de Historia Natural de Baleares*, 17: 73-75.
- GASULL, L., 1985, Fauna malacologica continental de la provincia de Huelva. *Miscellanea Zoologica*, 9: 127-143.
- GITTENBERGER, E., 1969, Eine neue Art der Gattung *Helicopsis* (Gastropoda, Helicidae, Helicellinae) aus Niederösterreich. *Basteria*, 33 (1-4): 63-68.
- GITTENBERGER, E., M. R. ALONSO & M. IBANEZ, 1989, *Helix pavid*a Mousson, 1872, and *H. nubivaga* Mabile, 1882 (Gastropoda, Helicidae, Helicellinae) poorly known Helicellinae from the Canary Islands. *Basteria*, 53 (4-6): 117-125.
- GITTENBERGER, E. & M. Y. MANGA, 1977, Some new species of the genus *Helicella* (Pulmonata: Helicidae) from the province Leon. *Zoologische Mededelingen (Leiden)*, 51 (11): 177-189, pls. 1-2.
- GITTENBERGER, E. & J. G. M. RAVEN, 1982, A new *Helicella* (Helicidae, Helicellinae) from the Cantabrian Mountains, Spain. *Basteria*, 46 (1-4): 79-83.
- GIUSTI, F., 1973, Notulae malacologicae, XVIII. I molluschi terrestri e salmastri delle Isole Eolie. *Lavori della Società Italiana di Biogeografia*, (n.s.), 3: 113-306, pls. 1-16.
- GIUSTI, F. & G. MANGANELLI, 1987, Notulae malacologicae XXXVI. On some Hygromiidae (Gastropoda: Helicoidea) living in Sardinia and in Corsica. (Studies on the Sardinian and Corsican malacofauna VI). *Bollettino Malacologico*, 23: 123-206.
- GIUSTI, F. & G. MANGANELLI, 1989, Notulae malacologicae, XLV. A new Hygromiidae from the Tyrrhenian islands of Capraia and Sardinia with notes on the genera *Xeromicra* and *Xerotricha* (Pulmonata: Helicoidea). *Bollettino Malacologico*, 25 (1/4): 23-62.
- GIUSTI, F. & G. MANGANELLI, 1990, *Ciliellopsis oglasae* a new Hygromiidae from Montecristo Island (Pulmonata: Hygromiidae). *Journal of Conchology*, 33: 269-277, pls. 27-29.
- GROSSU, A. V., 1983, *Gastropoda Romaniae 4. Ordo Stylommatophora Suprafam.: Arionacea, Zonitacea, Ariophantacea si Helicacea*. Bucuresti, Editura Litera, 564 pp.
- HAUSDORF, B., 1988, Zur Kenntnis der systematischen Beziehungen einiger Taxa der Helicellinae Ihering 1909 (Gastropoda: Hygromiidae). *Archiv für Molluskenkunde*, 119 (1/3): 9-37.
- HAUSDORF, B., 1990a, Die *Xeromunda*-Arten des griechischen Festlandes (Gastropoda: Hygromiidae). *Archiv für Molluskenkunde*, 119 (4/6): 407-432.
- HAUSDORF, B., 1990b, Zur Kenntnis einiger Arten der Gattung *Helicopsis* Fitzinger aus Griechenland und der Türkei (Gastropoda: Hygromiidae). *Archiv für Molluskenkunde*, 120 (1/3): 57-71.
- HAUSDORF, B., 1990c, Über die Verbreitung von *Microxeromagna armillata* (Lowe, 1852) und *Xerotricha conspurcata* (Draparnaud, 1801) in Griechenland und der Türkei (Gastropoda, Pulmonata: Hygromiidae). *Malakologische Abhandlungen*, 15: 55-62.
- HENNIG, W., 1966, *Phylogenetic systematics*. University of Illinois Press, Urbana, 263 pp.
- HESSE, P., 1934, Zur Anatomie und Systematik paläarktischer Stylommatophoren. *Zoologica (Stuttgart)*, 33 (1), Heft 85: 1-59, pls. 1-9.
- KTARI, M. H. & M. REZIG, 1976, La faune malacologique de la Tunisie septentrionale. *Bulletin de la Société des Sciences Naturelles de la Tunisie*, 11: 31-74.
- MADDISON, W. P., M. J. DONOGHUE & R. MADDISON, 1984, Outgroup analysis and parsimony. *Systematic Zoology*, 33: 83-103.
- MANGA GONZALES, M. Y., 1983, *Los Helicidae (Gastropoda: Pulmonata) de la provincia de Leon*. Leon, 394 pp.
- MANGANELLI, G. & F. GIUSTI, 1988, Notulae malacologicae, XXXVIII. A new Hygromiidae from Italian Apennines and notes on the genus *Cernuella* and related taxa (Pulmonata: Helicoidea). *Bollettino Malacologico*, 23: 327-379.
- MANGANELLI, G. & F. GIUSTI, 1989, Notulae malacologicae, XLIII. *Xeromunda* Di Maria Di Monterosato in Italy (Pulmonata: Hygromiidae). *Bollettino Malacologico*, 25 (1-4): 1-22.
- MANGANELLI, G., I. SPARACIO & F. GIUSTI, 1989, New data on the systematics of two Sicilian land snails, *Helix parlatoris* Bivona, 1839 and *Helix reinae* L. Pfeiffer, 1856 and description of *Schileykiella* n.gen. (Pulmonata: Hygromiidae). *Journal of Conchology*, 33: 141-156, pls. 10-16.
- NELSEN, G. I., 1979, Cladistic analysis and synthesis: principles and definitions, with a historical note on Adanson's "Familles des plantes" (1763-1764). *Systematic Zoology*, 28: 1-21.
- NORDSIECK, H., 1987, Revision des System der

- Helicoidea (Gastropoda: Stylommatophora). *Archiv für Molluskenkunde*, 118: 9–50.
- ORTIZ DE ZARATE Y LOPEZ, A., 1950, Observaciones anatomicas y position sistematica de varios helicidos espanoles. *Boletin de la Real Sociedad Española de Historia Natural*, 43: 21–85, pls. 1–2.
- PAULUCCI, M., 1878, *Matériaux pour servir a l'étude de la faune malacologique terrestre et fluviatile de l'Italie et des ses îles*. iv + 54 pp. Paris.
- PIANTELLI, F., F. GIUSTI, F. BERNINI & G. MANGANELLI, 1990, The mollusc and oribatid fauna of the Aeolian and Tuscan Archipelagos and the island equilibrium theory. In: Proceeding of the international symposium "Biogeographical aspects of insularity" (Roma 18–22 May 1987). *Accademia Nazionale dei Lincei, Atti dei Convegni Lincei*, 85: 117–154.
- PLATNICK, N. I., 1989, An empirical comparison of microcomputer parsimony programs. II. *Cladistics*, 5: 145–161.
- PRIETO, C. P., 1986, *Estudio sistematico y biogeografico de los Helicidae (sensu Zilch, 1959–60) (Gastropoda: Pulmonata: Stylommatophora del Pais Vasco y regiones adyacentes*. Universidad del Pais Vasco, Facultad de Ciencias, doctoral thesis, 393 pp., 10 pls.
- SCHILEYKO, A. A., 1978a, Molluscs. Land molluscs of the superfamily Helicoidea. *Fauna SSSR*, (n.s.) 17: 1–348 [in Russian].
- SCHILEYKO, A. A., 1978b, On the systematics of *Trichia* s. lat. (Pulmonata: Helicoidea: Hygromiidae). *Malacologia*, 17: 1–56.
- SCHILEYKO, A. A., 1984, Molluscs. Terrestrial molluscs of the suborder Pupillina of the fauna of the USSR (Gastropoda, Pulmonata, Geophila). *Fauna SSSR*, (n.s.) 130: 1–399. [in Russian].
- WATROUS, L. & Q. WHEELER, 1981, The outgroup comparison method of character analysis. *Systematic Zoology*, 30: 1–11.
- WESTERLUND, C. A., 1889, *Fauna der in der palaarktischen Region lebenden Binnenconchylien. II. Genus Helix*, 2, 473 + 30 pp. R. Friedländer & Sohn., Berlin.
- ZILCH, A., 1960, Euthyneura. In W. WENZ: *Gastropoda. Handbuch der Paläozoologie*, 6 (2, 4th part): 601–835 + i–xii.

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